

L. L. NARAYANA* & M. RADHAKRISHNAIAH*: **Floral anatomy
of Pittosporaceae (3)****

L. L. ナラヤナ*・M. ラダクリシュナイア*: トベラ科の
花部解剖学的研究 (3)

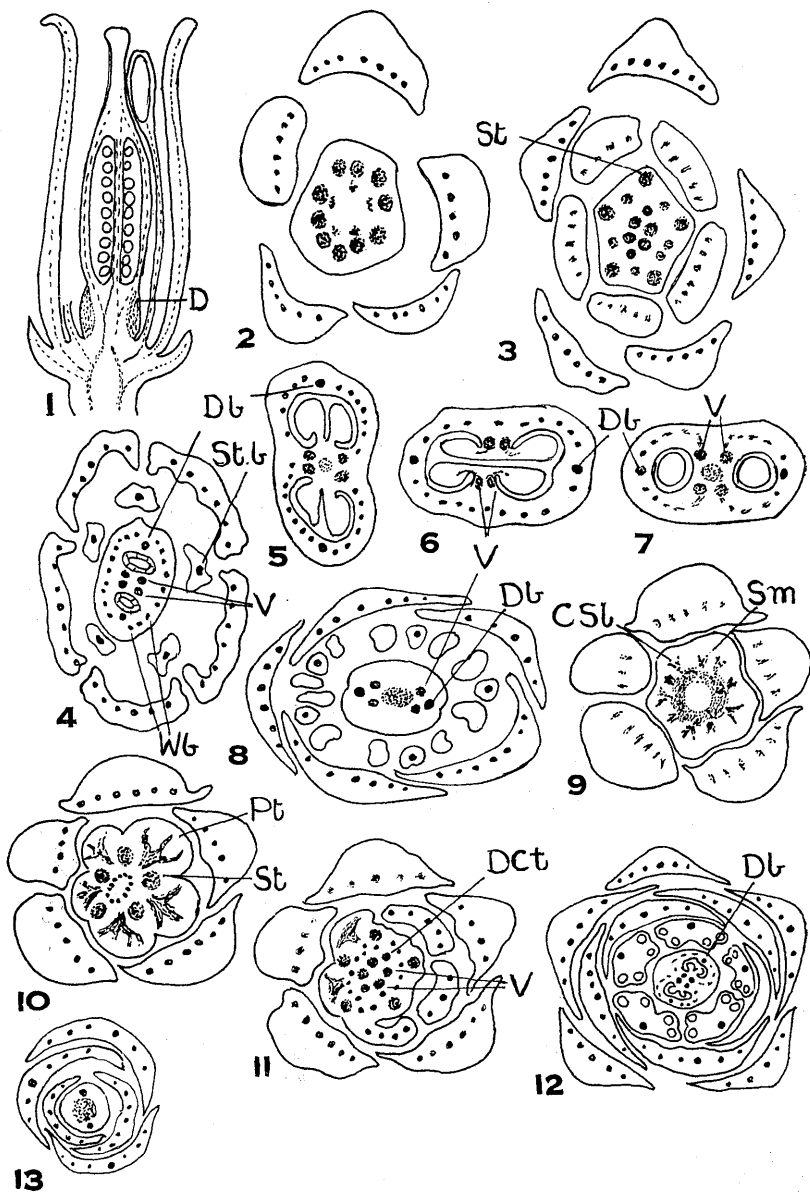
There are only a few published accounts on the floral anatomy of Pittosporaceae by Saunders (1939), Schaeppi (1971), Narayana & Radhakrishnaiah (1976, 1978), Radhakrishnaiah & Narayana (1977, 1978). The present paper deals with the floral anatomy of seven species of *Billardiera* viz., *B. angustifolia* C. A. Gard., *B. coriacea* Benth., *B. cymosa* Klatt., *B. latifolia* Putterl., *B. lehmanniana* F. Muell., *B. scandens* SM., and *B. verifolia* DC.

Materials and Methods The materials were fixed in F. A. A. Customary methods of dehydration and embedding were followed. Sections of flower buds of different ages cut at a thickness of 8–12 μ were stained in crystal violet using erythrosin as counterstain. The herbarium material of *B. scandens* was processed following the procedure described by Narayana (1964).

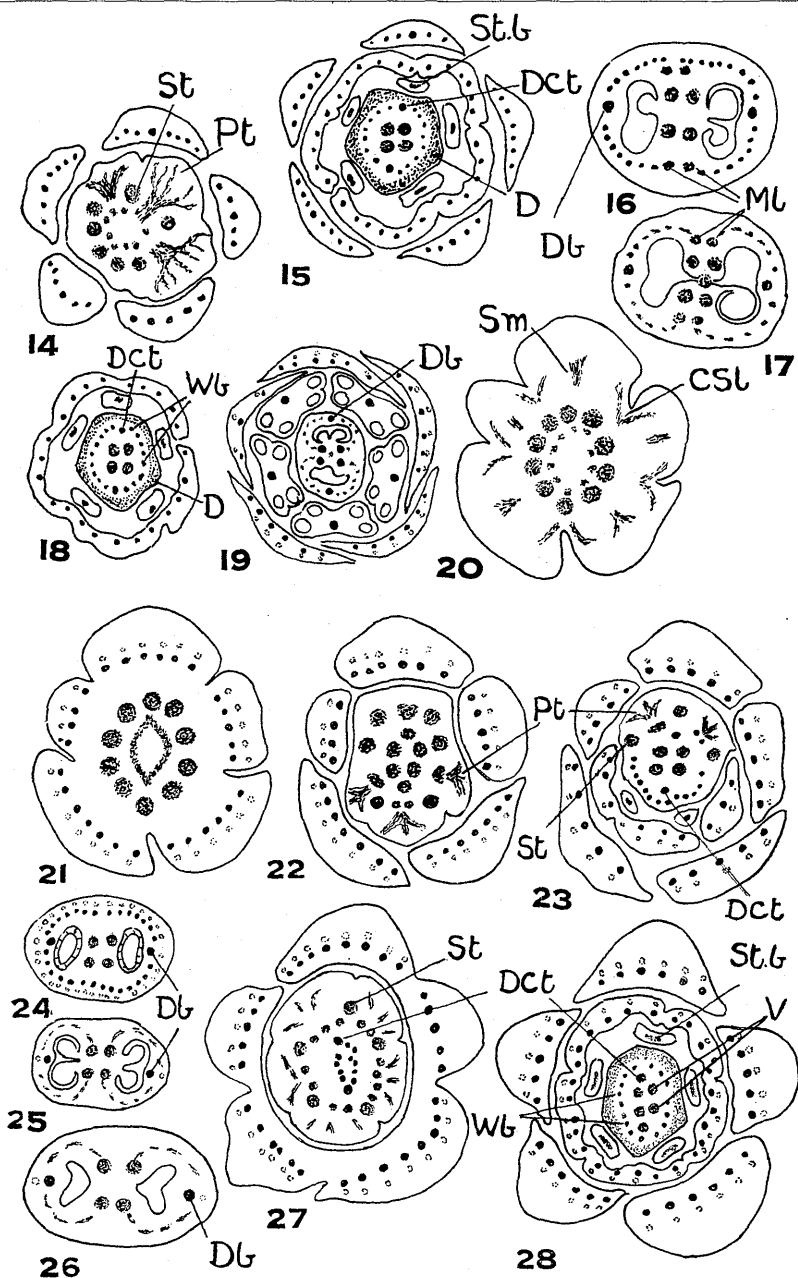
Observations The flowers are pedicellate, complete, tetracyclic, hetero-chlamydeous, bisexual, actinomorphic, hypogynous and pentamerous except the gynoeceum (Figs. 1, 12). The 5 free sepals show quincuncial aestivation in *B. angustifolia*, *B. coriacea*, *B. cymosa* and *B. lehmanniana* (Figs. 2, 3, 10–12, 15, 23). The free limbs of basally connate calyx in *B. scandens* and *B. verifolia* show quincuncial and imbricate aestivation respectively (Figs. 28, 31). The pentamerous corolla is polypetalous in *B. angustifolia*, *B. coriacea* and *B. verifolia* (Figs. 3, 8, 12, 33) and basally connate in *B. cymosa*, *B. latifolia*, *B. lehmanniana* and *B. scandens* (Figs. 15, 18, 23). The aestivation is imbricate in *B. angustifolia* and *B. latifolia* (Figs. 8, 19) and quincuncial in *B. coriacea*, *B. cymosa*, *B. lehmanniana*, *B. scandens* and *B. verifolia* (Figs. 12, 33). The androeceum consists of 5 free stamens with flat filaments and dorsifixed anthers (Figs. 4, 12, 15, 18, 19, 28, 33). The ovary is bicarpellary syncarpous and bilocular throughout in all the species

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Figs. 1-13. 1: Semi-diagrammatic longitudinal section of flower of *Billardiera angustifolia*, showing the course of vascular bundles in the different floral parts. 2-13: Serial transverse sections of flower buds, showing the origin and distribution of traces to the different floral parts; 2-8, *Billardiera angustifolia*; 9-13, *B. coriacea*. 2-4, 8, $\times 21$. 5-7, $\times 3$. 9-13, $\times 14$. For abbreviations, see legend of Figs. 29-34.



(Figs. 12, 16, 17, 19, 24-26, 32, 33) except in *B. angustifolia*, where it is bilocular at the base and apex and unilocular in the middle (Figs. 4-7). The style is solid and filled with transmitting tissue (Figs. 8, 13, 34) and the stigma is bilobed.

The pedicel shows 4 discrete collateral vascular bundles of equal size in *B. coriacea*, 5 bundles of unequal size in *B. verifolia*, 7 bundles in *B. angustifolia* and *B. scandens*. In *B. cymosa*, *B. latifolia* and *B. lehmanniana* the pedicel shows a ring of vascular tissue.

In the thalamus the sepal midribs and the common sepal lateral traces arise in 2 close alternating whorls. The latter divide radially and demarcate the lateral traces of adjacent sepals (Figs. 9, 20, 29).

After the divergence of the sepal traces the stele organizes into 10 prominent bundles (Figs. 2, 20, 21) from which branches are given off towards inside. These bundles converge towards the centre to form a ring of bundles as in *B. cymosa* (Fig. 14), *B. latifolia*, and *B. scandens*, or a closed ring of vascular tissue as in *B. coriacea* and *B. lehmanniana* (Figs. 10, 21). At this level there is an inner ring of vascular tissue and an outer ring, consisting of 10 prominent bundles.

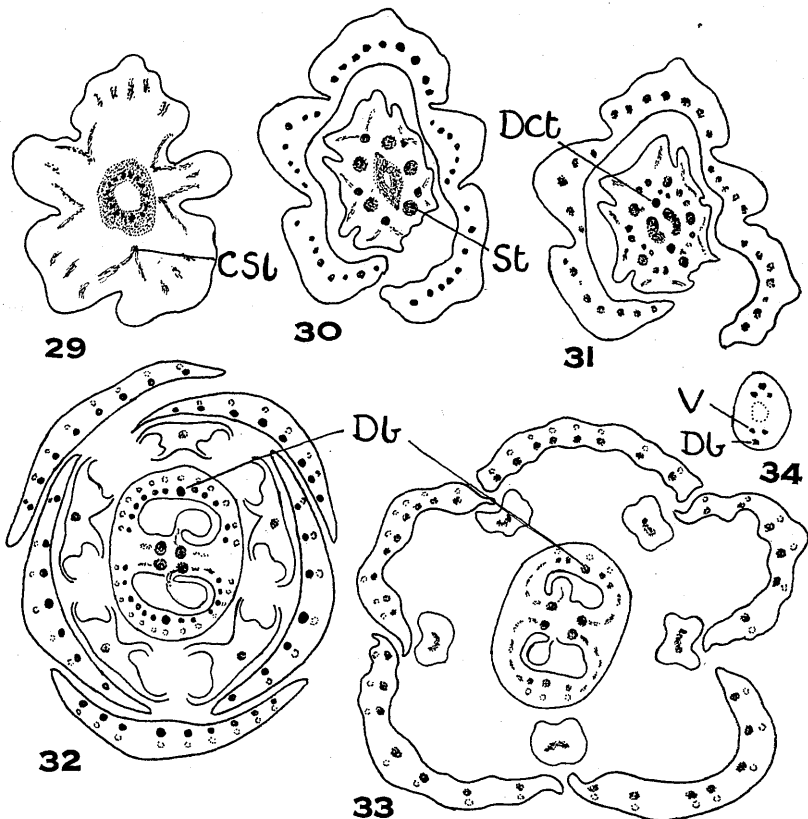
A pair of dorsal bundles and 2 pairs of ventral bundles are organized from the inner ring of bundles or ring of vascular tissue in *B. coriacea* (Fig. 11), *B. latifolia*, *B. lehmanniana* (Fig. 22) and *B. scandens* (Figs. 27, 28), while in *B. cymosa* only 2 pairs of ventral bundles are organized (Fig. 15). In *B. angustifolia* and *B. verifolia*, 5 of the 10 bundles, which lie along the sepal radii give off branches towards inside; these converge at the centre to form a ring of vascular tissue from which a pair of dorsal bundles and 2 pairs of ventral bundles are organized (Figs. 2, 3). After the organization of dorsal and ventral bundles or only ventral bundles as in *B. cymosa*, 5 of the 10 bundles along sepal radii function as staminal traces and the alternating 5 as petal traces (Figs. 10, 14, 22, 23).

Besides the dorsal and ventral bundles the ovary receives additional vasculature derived from the emerging petal and staminal traces as in *B.*

Figs. 14-28. Serial transverse sections of flower buds, showing the origin and distribution of traces to the different floral parts. 14-17, *Billardiera cymosa*. 18-19, *B. latifolia*. 20-26, *B. lehmanniana*. 27-28, *B. scandens*. 14-15, $\times 14$. 16-23, $\times 21$. 24-25, $\times 3$. 26, $\times 5$. 27-28, $\times 12$. For abbreviations, see legend of Figs. 29-34.

coriacea (Fig. 11) and *B. verifolia* (Figs. 31, 32) and from emerging petal traces as in *B. angustifolia* (Fig. 14), *B. latifolia*, *B. lehmanniana* (Fig. 22) and *B. scandens* (Fig. 27). The dorsal bundles in *B. cymosa* organized from the branches given off by the emerging petal traces become distinguishable at about the level where the stamens separate from the thalamus (Fig. 15).

The ovary is bilocular throughout (Figs. 12, 16, 17, 19, 24-26, 32, 33) except in *B. angustifolia*, where it is bilocular at the base and apex and



Figs. 29-34. Serial transverse sections of flower buds of *Billardiera verifolia*, showing the origin and distribution of traces to the different floral parts. 29, $\times 12$. 30-34, $\times 21$. Abbreviations: Csl, common sepal lateral. D, disc. Db, dorsal bundle. Dct, dorsal carpellary trace. Ml, median lateral bundle. Pt, petal trace. Sm, sepal midrib. St, staminal trace. St. b, staminal bundle. V, ventral bundle. Wb, wall bundle.

unilocular in the middle (Figs. 4-7). There is pairing of homocarpellary ventral bundles and these lie opposite the loculi (Figs. 12, 16, 17, 19, 24-26, 32, 33). In *B. angustifolia*, the pairing is between heterocarpellary ventral bundles (Figs. 4-7). Besides giving off traces to the ovules, the ventral bundles give off branches which traverse the ovary wall and terminate towards the apex (Figs. 6, 7, 12, 19, 25, 32, 33). In *B. cymosa* the bundles of the wall of the ovary nearest to the ventral bundles are more prominent and function as median lateral bundles, which give off branches into the wall of the ovary and these fade away at a higher level (Fig. 17).

The style is filled with transmitting tissue and is vascularised by dorsal and ventral bundles in *B. angustifolia* (Fig. 8), *B. cymosa*, *B. latifolia* and *B. verifolia* (Fig. 34) and by dorsal bundles alone in *B. coriacea* and *B. lehmanniana* (Fig. 13).

The massive disc-like basal part of the ovary is non-vascularised and the cells in this region show deep staining and vacuolated cytoplasm (Figs. 15, 18, 28).

Discussion Concomitant with the simplicity of floral structure in *Bilardiera*, there are interesting variations in the vascular anatomy of the different species investigated.

The calyx is polysepalous in *B. angustifolia*, *B. coriacea*, *B. cymosa*, *B. latifolia*, and *B. lehmanniana*, while it is basally connate in *B. scandens* and *B. verifolia*. The sepals are 3-traced and connation between lateral traces of adjacent sepals is noticed in species with polysepalous calyx and in species where the sepals are basally connate and this indicates that connation of traces has preceeded the external fusion of parts. Similar conclusions have been arrived at, in regard to *Marianthus bignonaceus* (Narayana & Radhakrishnaiah, 1978) and *Pronaya elegans* (Radhakrishnaiah & Narayana 1977).

The petals and the stamens are single-traced. The carpels are 3-traced except in *B. cymosa*, where they are 5-traced. There is variation in the organization of gynoeceal vasculature. The dorsal and ventral carpellary traces in *B. coriacea*, *B. latifolia*, *B. lehmanniana* and *B. scandens* and only the ventral carpellary traces in *B. cymosa* are organized from the branches given off towards the centre by the 10 bundles in the thalamus after the organization of sepal traces; in *B. angustifolia* and *B. verifolia*, however, they are organized by the branches given off by the 5 of the 10 bundles,

which lie along the sepal radii. While in *B. angustifolia*, *B. cymosa*, *B. latifolia*, *B. lehmanniana* and *B. scandens*, additional vasculature to the ovary wall is derived from the emerging petal traces, it is derived from both petal and staminal traces in *B. coriacea* and *B. verifolia*. In the organization and behaviour of median lateral bundles, *B. cymosa* resembles *Bursaria spinosa* (Narayana & Radhakrishnaiah, 1976), *Marianthus procumbens* (Narayana & Radhakrishnaiah, 1978) and *Pittosporum floribundum* (Radhakrishnaiah & Narayana, 1978). Though external adnation between the ovary and the stamens and the petals is absent, the derivation of the vascular supply to the gynoecium speaks of adnation between their traces. It may be pointed out that adnation between traces of gynoecium, androecium and corolla preceded their fusion externally.

Judging from the position of the paired homocarpellary ventral bundles, the placentation can be interpreted as axile and in *B. angustifolia* as parietal below and anatomically parietal above, where the ovary is bilocular.

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トベラ科の *Billardiera* 属の7種類の花の構造を調べた。すべての種類で萼は維管束環から1本の中央維管束と2本の側部維管束の3本の維管束が入り、花卉と雄しべはそれぞれ1本の維管束が入る。子房は2室で2枚の心皮からなる。各心皮には *B. cymosa* を除いて1本の背行維管束と2本の腹行維管束の3本の維管束が入る。*B. cymosa* のみはその他に2本の側部背行維管束があり、全部で5本みられる。*B. angustifolia* を除いてすべて中軸胎座と考えられるが、*B. angustifolia* は下部は側膜胎座であり、上部も外見上は中軸胎座であるが、解剖的には側膜胎座である。

○外来の *Solidago* 属植物に関する追記 (浅井康宏) Yasuhiro ASAI: Additional notes on some *Solidago* species introduced to Japan

近年、栽培逸出起源の帰化植物として北アメリカ原産のトキワアワダチソウ *Solidago sempervirens* L., Sp. Pl. 878 (1753) が、筆者らにより東京近郊から記録された。本種は、その草姿や米名 Seaside Goldenrod からもうかがえるように、本属の中でも海岸地帯に適応した異端的な存在であるといえる。筆者も先年、テキサス州の海岸塩性砂泥地で本種の生育状態を実見したが、正に我国のハマアカザのそれに似た環境に生育し、ロゼットのみをみれば、とても本属の仲間とは思われぬようなものであった。

ところで植物の分布調査などについて、夙に令名ある富樫 誠氏によれば、現在、我国でみられるものの移入は、近年のことではなく、第二次大戦後に兵庫県下の園芸植物商に由来するものの由 (東大のハーバリウムには、1950年代に同氏により採集された有花の標本が収蔵されている) である。なお筆者は、これとは別に過日、東大理学部植物学教室のハーバリウムに保存されている本属の帰化品を再検中、本種と思われるものが、既に昭和十年代に東京大学理学部附属の小石川植物園に栽培され、これが津山 尚博士により採集された標本 (2個体を4枚のシートに貼布し、ラベルには1939年11月、T. Tuyama とあるが、いずれも sterile 未検定である) が所蔵されているのに気付いた。恐らく、当時、同園の園芸主任であった菰松崎直枝氏などが、その導入に直接関与したのではないかと想像される。したがって本種の渡来記録は、かなり古いものであることが明瞭となった。

ところで、図1は東京都足立区内の荒地に本種が完全な帰化状態となり、旺盛な生育を示している実状である。写真の手前にあるアシと混生して開花中のものが本種で、その背後に群生しているのがセイタカアワダチソウである (トキワアワダチソウは生育環境によって、セイタカアワダチソウよりも草姿などが、むしろ壮大となる)。後者は未だ開花するに至っておらず、この両者はその形態のみならず、開花期の相違によっても容易に区別できる。なお、ここに掲げた写真の場所の近くには、かつて本種が大規模に栽培されたと思われる荒廃した畑があり、恐らくこれを元にして周辺地域